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Response to Accelerating Research through International Network Collaboration

- Dear Colleague Letter: https://www.nsf.gov/pubs/2017/nsf17131/nsf17131.jsp
- Webinar presentation: https://www.nsf.gov/attachments/243183/public/AccelNet_Webinar_Slides_for_Website_10-12-17.pdf
- Deadline: 11:59 p.m. **Eastern Time** November 30, 2017
- 2013 mini-symposium presentations on ILTER projects: http://intranet2.lternet.edu/documents/263

Background:
groffmanp@caryinstitute.org
This DCL is **not** a call for research proposals. Rather, it is an information-gathering effort to inform OISE of the potential need for a future program or program emphasis. No funding is associated with this call for white papers. The DCL and the webinar emphasize the importance of these international collaborations to accelerating and leveraging US research. Like it or not, this is not an altruistic venture.

Responses to the questions asked in the DCL

Questions:

- **Name, affiliation, and valid email contact information for submitter(s).**
  - Peter Groffman, Bill McDowell, Tiffany Troxler, Frank Davis, Marty Downs
  - On behalf of LTER Science Council and the LTER Network Communications Office
  - Peter.Groffman@asrc.cuny.edu , Bill.McDowell@unh.edu, troxlert@fiu.edu, frank.davis@nceas.ucsb.edu, downs@nceas.ucsb.edu
- **List up to three terms that represent keywords of your submission (This may be made public in aggregate with other submissions).**
  - Long-term ecological research
  - Ecosystems ecology
  - Modeling

What current or emerging research areas would benefit from increased cooperation between networks of researchers in the U.S. and networks in one or more countries outside the U.S.?

(Target: 750 words; Currently 661 words)

Within the discipline of environmental sciences, we see three broad kinds of research that would particularly benefit from improved international cooperation:

- broadening the inference space for ecological research;

- understanding transport mechanisms for energy, water, nutrients, and species;
- ecosystem modeling.

We elaborate on each and offer examples of specific research areas and recent accomplishments or emerging projects that are primed to make substantial advances.

Broadening the inference space for comparative research

Many of the ecosystems that we study are globally distributed, e.g, boreal, Arctic, arid, urban, and agricultural span the globe. There is a critical need for understanding variation within these biomes/ecosystems and for developing true global-scale research.

Strong inference in ecosystem ecology requires both an intimate understanding of specific systems and a population of ecosystems that experience a wide range of environmental conditions, legacies, and trajectories. Just as we would not expect to understand the controls on human health by studying the residents of one neighborhood, we cannot expect to develop a robust understanding of how ecosystems function by studying one coral reef or one mountain range.

There is much that can be accomplished through meta-analysis of short-term studies, both U.S.-based and international--but certain types of questions are extraordinarily difficult to address without the ability to compare long-term, comparably-collected observations. These include:

- What are the legacy effects of past land cover, land use, community structure, and management regimes?
- What are the fundamental controls on ecosystem functioning such as forest growth, stream chemistry, population dynamics, and CO_2 and trace gas emissions from plants and soils.
- How does biodiversity affect ecosystem services and what kinds of biodiversity are most important? How do top predators shape community structures and ecosystem services?
- Is it possible to predict thresholds in ecosystem functioning? What are the fundamental principles of resilient ecosystems?

Transport mechanisms

We live in a connected world. While information and ideas flow over the internet; carbon, nutrients, water, energy, and exotic species flow through river networks, ocean currents, atmospheric transport, and trade. Dust from the Sahara affects the growth and sustainability of Puerto Rican forests. Rivers flowing out of half a dozen countries shape the functioning and productivity of the Arctic Ocean. Patterns of trade, shipping, and regulation bring new species and occasionally new diseases to U.S. shores. Worldwide, agricultural and development practices affect coastal zones thousands of miles away.

International collaboration, particularly through long-term studies, can help establish the existence of, controls on, and impacts of these transport mechanisms. The Arctic Great Rivers Observatory, for example, developed a 80-year dataset of river flow for six major rivers flowing into the Arctic Ocean by drawing on existing records. But the team could not directly compare nutrient outputs without reconciling data collection and analysis methods, which required more active collaboration. Recent outputs from the Observatory include papers on remobilization of permafrost carbon, implications for wildfire-stream metabolic linkages, implications of mercury discharges and sediment burial, and enzymatic controls on metabolism of Arctic river organic matter.

Similar networks, either broad-based like the International Nitrogen Initiative or centered around locations and types of transport like the Arctic Great Rivers Observatory, could yield a much deeper understanding of how energy, water, and key nutrients move through the global environment.

Modeling

Robust global-scale models of the biosphere and biosphere-atmosphere interactions require inputs of drivers and understanding of feedbacks. Global scale datasets exist for drivers such as land use, land cover, precipitation, and some measures of productivity; but it remains extraordinarily difficult to assemble global scale data for factors that cannot be remotely sensed. What might be the impact of carbon quality, micronutrients, biodiversity, or community stability on climate, ecosystem functioning or ecosystem services? If they can't be incorporated into models because the data isn't available at the right scale or density, we may never be sure. By harmonizing long-term research efforts through networks such as the International Long-Term Ecological Research Network, we begin the process of assembling usable, global-scale datasets that can be incorporated into models.

What is the value added of international network-to-network collaboration for the U.S. research community in the research area(s)?

(Target: 750 words; current: 730)

One major way that ecology advances is by comparing the functioning of ecological processes in similar systems that are subject to different starting conditions, drivers, or management approaches. For example, researchers might hypothesize that the presence of nearby natural habitat reduces the use of pesticides on agricultural crops by increasing populations of natural predator insects, but US farmers employ a limited number of farming approaches, patch sizes, and a limited range of soil and habitat types. Partnering with international researchers would allow them to include a much wider range of approaches, including terraced fields, dryland agriculture, large-scale organic farming; and a wider range of climatic conditions, including temperature, precipitation, day-length and growing season-length. The findings resulting from such a broad-based study would be more robust and more general than those resulting only from a handful of US-based long-term agro-eco sites.

The National Science Foundation and other agencies have made major investments in long-term ecological research networks, including LTER, NEON, CZO, LTAR, and Ameriflux. Researchers in these networks produce a steady stream of new site-based research and cross-network synthetic studies, but could dramatically extend the value of their findings through cooperation and comparison with similar international networks.

In a few specific cases, such as coral reefs, kelp forests, mangrove systems, tropical forests, alpine, and Arctic ecosystems--the U.S. LTER Network has only one site of each type. For those sites, long-term comparative studies require either additional U.S. sites or collaboration with existing international sites. Indeed, these types of sites have been strongly supportive of the International LTER (ILTER) Network and similar networks with a more thematic focus, such as the Complex Mountain Landscapes Network, Kelp Ecosystem Ecology Network (KEEN), the Smithsonian Forest GEO Network, International Arctic Science Committee (IASC), and the Sustaining Arctic Observing Networks (SAON).

Over the next decades, ecosystems of the United States will experience changing conditions (plant-insect interactions, disease spread, pollinators, temperature and moisture regimes, soil conditions, changes in cultivation practices) many of which we have not previously experienced. Enhanced collaborations with international colleagues provide glimpses into our past and our future. Adaptation in urban and other managed ecosystems is one particularly profound challenge that can only be addressed by broadening the range of environmental and socioeconomic conditions and cultural legacies of research sites.

Network-to-network collaborations enable U.S. researchers to easily identify international sites that extend the range of environmental conditions and to connect with enthusiastic collaborators who share a common vision of the value of long-term site-based research. The International LTER Network (ILTER) has launched several new research efforts to address global scale dynamics of biodiversity, nitrogen and other topics, and maintains an extensive database of site characteristics, projects, investigators, and data. By participating in these efforts and drawing on this database and a network of colleagues established through occasional meetings and trainings, U.S. researchers can connect with international sites and jointly pursue research funding.

Distributed Experiments

In the past decade, ecology has seen the rapid growth of a new type of experiment in which a fairly simple protocol is carried out at many, widely-distributed locations. These distributed experiments (DroughtNet, NutNet, Detritus Input Removal and Trenching (DIRT) and the Tea Bag Index) are a key bridge between continental scale networks and in-depth site-based studies that reveal principles that are ripe for testing in wider contexts. The current set of distributed experiments have benefited from the existence of the ILTER network in recruiting appropriate sites and researchers, but the process could be accelerated by the presence of a stronger and broader network-to-network relationship.

Training and Culture of Science

International collaborations broaden the horizons of U.S.-based trainees, exposing them to new techniques, approaches, cultures, and practices, as well as connecting them to a global network of advanced researchers. International training courses, such as those developed by the International Nitrogen Training Initiative, rely on network-to-network connections to structure the course material, identify instructors, and recruit the most promising students. These experiences feed back to the success of U.S. scientists in understanding both U.S. and global-scale phenomena.

In addition, strong U.S. participation in international network-to-network collaboration helps build a global culture of science that supports active collaboration, data sharing, transparency, and the open exchange and discussion of ideas. The extent to which this culture prevails in international research endeavors will strongly influence the rate of discovery for both U.S. and international scientists.

What other relevant aspects should NSF consider to strengthen international research networks in the research area(s)?

(Target: 750 (words); Currently: 619)

ILTER background and relationship with U.S. networks

The International LTER Network was founded on the model of the U.S. LTER Network and operates as a network of country-based networks. Its focus is on long-term, place-based research from an ecosystem perspective. It includes 44 member networks and over 800 sites in almost every biome on Earth. Both developed and developing countries are welcome and dues and meeting fees differ based on a country's development status. As in the U.S. LTER Network, data preservation, sustainability, and access are priorities.

The ILTER Network has successfully connected countries with strong internal networks and has had some success in including individual sites in countries without a network, but it faces several challenges moving forward.

ILTER is mature enough to begin setting research agendas--an activity that could profoundly affect the opportunities and success of U.S. scientific collaborations with international partners. It is important that the U.S. be an active participant in these discussions. At the same time, the U.S. LTER Network lacks a mechanism for engaging fully with the ILTER Network. For the past several years, the U.S. LTER Network has been unable to pay dues and has only been able to attend coordinating committee meetings because the ILTER committee chairs committed external funds. In 2017, the U.S. LTER Network paid a portion of its dues, keeping its membership active, but casting doubt over continued

U.S. participation. This limits the influence of U.S. participants in decision-making and weakens the Network as a whole.

The ILTER structure relies on a single lead organization in each country (U.S. LTER in the United States), but long-term environmental science in the U.S. is distributed across several organizations and funding mechanisms. These include NEON, CZO, OBFS, LTAR, LTREB and Macrosystems projects. There is currently no mechanism for incorporating input from these other networks--or even for recognizing long-term sites that belong to networks other than LTER. In the short term, a lead U.S. organization could coordinate activities with other U.S. Networks, but in the long-term, ILTER will need to grapple with this phenomenon. Ultimately, an inclusive network of international networks could help harmonize membership requirements, data, and scientific approaches.

The landscape of international environmental research

Both sites and researchers from the U.S. LTER Network actively participate in several thematic international networks, including Smithsonian's Forest Global Earth Observatories, INTERACT, and KEEN in addition to ILTER. We view these networks as complementary to ILTER, with the data and network assembled by ILTER providing a scaffold from which to launch new projects and thematic networks as the need arises.

Similarly, ILTER is not a major research funder, though it does seed new projects and trainings. The major channels for funding of international environmental research are the Belmont Forum, Future Earth and Global Environmental Facility, but these all share a focus on applied and translational research in service of the sustainable development goals. This leaves an unfilled funding need in the area of basic, process-based environmental research of the kind that informs global models and spurs discovery of new principles.

The most fertile ground for discovery is found in the interactions of a few scientists around specific questions. Some amount of seed funding is essential for launching those collaborations and a well-functioning network plays a key supporting role in:

- identifying potential collaborators;
- locating comparable sites and sites that extend the inference space; and
- building the culture and capacity to support active collaboration.

Successful scientist-to-scientist collaborations strengthen and expand the network and promote additional collaboration. We believe that any funding mechanism resulting from this RFI will be most successful if it includes support for both network structure and seeding scientific collaborations.